34572
REPORT NO. KAPL-915

General Electric Company
KNOLLS ATOMIC POWER LABORATORY
Schenectady, New York

Classification changed to Unclassified
by authority of W. Sullivan 1/24/56
by Walter Kinn date 1/16/07
and Dand Bell date 2/1/2007

HEALTH PHYSICS REPORT

FOR JANUARY, FEBRUARY, MARCH 1953

L. L. German, Manager

L. J. Cherubin, Radiological Services Sub-Unit
R. Z. Bouton, Radiological Laboratory and
Development Sub-Unit

Photostat Price \$ 4.80

Microfilm Price \$ 2.70

Available from the
Office of Technical Services
Department of Commerce
Washington 25, D. C.

Operated for the
United States Atomic Energy Commission
by the
General Electric Company
Contract No. W-31-109 Eng-52

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

KAPL-915

Health and SafetyInternal DistributionCopy Number

AEC, Schenectady Operations Office	1-2
Anderson, JD	3
Bouton, RZ	4
Burke, JE	5
Cherubin, LJ	6
Davis, M	7
Document Library	8-11
German, LL	12
Kingdon, KH	13
Marsden, J	14
Morrison, JO	15
Prentice, BR	16
Rozendael, HM	17
Tonks, L	18
Trocki, T	19
Vroman, DF	20

External Distribution

Aeromedical Laboratory (WADC)	21
ANP Project Office, Fort Worth	22
Argonne National Laboratory	23-26
Armed Forces Special Weapons Project, Washington	27
Army Chemical Center	28
Atomic Energy Commission, Washington	29-31
Battelle Memorial Institute	32
Bechtel Corporation	33
Brookhaven National Laboratory	34-35
Brush Beryllium Company	36
Bureau of Medicine and Surgery	37
California Research and Development Company	38-39
Carbide and Carbon Chemicals Company (C-31 Plant)	40-41
Carbide and Carbon Chemicals Company (K-25 Plant)	42
Carbide and Carbon Chemicals Company (ORNL)	43-48
Carbide and Carbon Chemicals Company (Y-12 Plant)	49-50
Catalytic Construction Company	51
Chicago Patent Group	52
Chief of Naval Research	53
Columbia University (Failla)	54
Commonwealth Edison Company	55
Detroit Edison Company	56
Dow Chemical Company (Rocky Flats)	57

Issued JUN 17 1953

KAPL-915

External Distribution (Continued)Copy Number

duPont Company, Augusta	58-62
Foster Wheeler Corporation	63
General Electric Company (ANPP)	64-65
General Electric Company, Richland	66-68
Hanford Operations Office	69
Idaho Operations Office	70-75
Iowa State College	76
Los Alamos Scientific Laboratory	77-78
Mallinckrodt Chemical Works	79
Massachusetts Institute of Technology (Evans)	80
Massachusetts Institute of Technology (Kaufmann)	81
Monsanto Chemical Company	82
Mound Laboratory	83-85
National Advisory Committee for Aeronautics, Cleveland	86
National Lead Company of Ohio	87
Naval Medical Research Institute	88
Naval Research Laboratory	89
New Brunswick Laboratory	90
New York Operations Office	91-93
North American Aviation, Inc.	94-95
Nuclear Development Associates, Inc.	96
Patent Branch, Washington	97
Pioneer Service & Engineering Company	98
Public Health Service	99
RAND Corporation	100
Savannah River Operations Office, Augusta	101
Sylvania Electric Products, Inc.	102
The Surgeon General	103
USAF Radiation Laboratory	104
U. S. Naval Radiological Defense Laboratory	105
UCLA Medical Research Laboratory (Warren)	106
University of California Radiation Laboratory, Berkeley	107-110
University of California Radiation Laboratory, Livermore	111-112
University of Rochester	113-114
University of Tennessee (Comar)	115
University of Washington	116
Vitro Corporation of America	117-118
Western Reserve University (Friedell)	119-122
Westinghouse Electric Corporation	123
Technical Information Service, Oak Ridge	124-138

KAPL-915

CONTENTS

	<u>Page</u>
Summary	7
General	9
Organization and Personnel	10
Radiological Services	12
General Statistics	12
Personnel Exposures and Investigations	12
In-Plant Radiation Monitoring	13
Waste Disposal	14
Environmental Radiation Monitoring	14
Calibrations	18
Personnel Monitoring	19
Radiological Laboratory	21
General Statistics	21
Analytical	21
Bioassay	22
Development	23
Stack Effluent Studies	23
Aerosol Studies	24
Filter Efficiency Studies	25
Instrumentation and Calibration	27
General Investigations	28
U. S. Geological Survey	29
Hydrologic Investigations	29
Sampling Program	29
Tracer Study	30
Adsorption Studies	30
Personnel Services and Preparation of Reports	30

SUMMARY

Four total body overexposures* occurred with a maximum accumulated dose of 5.0 rep. Six head overexposures involved a maximum dose of 0.9 rep. Twenty-three total body exposures ranged from greater than 0.3 rep to less than 0.6 rep per week. Hand exposure studies disclosed four instances of accumulated doses exceeding 1.5 rep (maximum 2.1 rep). A total of 41 investigations pertaining to personnel exposure was requested from supervision. Six Radiation Hazards Incident Investigations were held; none involved serious exposure.

In-plant radiation surveys disclosed few deviations from typical findings. Facilities for radioanalysis required shielding improvement. Surface contamination control measures in the Separations Pilot Plant were reviewed because of general extension beyond established limits. The explosive rupture of a slurry drum in the Waste Processing Building created a challenging problem in decontamination.

Environmental monitoring revealed low-level atmospheric fission-product contamination as a result of Separations Pilot Plant stack discharge. Radioactivity in precipitation (snow or rain) is attributed primarily to continental atomic bomb tests. Both local and outside influences can be credited with the vegetation contamination with fission products. Radiation levels were not increased appreciably by the atmospheric contamination. Sewer effluent and Mohawk River water analyses indicated adequate control of radioactive waste discharges.

No significant excretion of plutonium, mixed fission products, enriched uranium, or natural uranium were detected through analysis of urine specimens. Several positive tritium excretions were detected; the maximum tritium activity was 17 $\mu\text{c/liter}$ of urine.

Studies were initiated of the particle collection efficiencies of several filter papers used in air monitoring and also of the essential calculations and derivations associated with the prediction of hazards resulting from unusual reactor incidents.

A neutron calibration unit which may serve as a substitute for the Sigma Pile was designed and fabricated. A new aerosol sampling unit was also designed.

Investigations of the Separations Pilot Plant stack effluent, the efficiency of the Special Products Shop air cleaning system, neutron spectra and neutron monitoring methods, and the maximum permissible concentration of thorium in air were continued.

The previous Health Physics Report, for October, November, December 1952, is KAPL-862.

*The term "overexposure" in this report merely indicates personnel exposure above the following levels: >0.6 rep in one or two weeks or >3.9 rep in 13 weeks.

HEALTH PHYSICS REPORT
FOR JANUARY, FEBRUARY, MARCH 1953

GENERAL

KAPL Instruction F-575, containing rules and procedures relating to beryllium hazard control, was issued.

An assessment of radiation hazards resulting from the dispersal of radioactive elements following a postulated nuclear incident relative to PTR was completed.

The contributions of Radiological Services to the SIR Mark A related to meteorology, the shield test program, review of specifications and prints, radiation monitoring instrumentation, and planning of personnel requirements.

Health Physics services were extended to the Metal and Control Corporation, Attleboro, Massachusetts.

The KAPL Emergency Planning Committee met to discuss the impact of certain emergencies involving radiation on personnel and plant protection. A subcommittee was designated to explore the nature of the hazards and suggest emergency steps. Radiological Services was represented on both committees.

Radiological Services requirements for atmospheric and radiation monitoring in Buildings E-3 and F were discussed. No final decisions regarding Building F were made.

Operations Services and Radiological Services personnel jointly discussed plans for the Sodium Test Facility and relocation of the solid waste storage facilities. Control of autoradiographing of certain SIR Mark A installations was reviewed with representatives of the Electric Boat Company.

Representatives of the U.S. Weather Bureau visited KAPL to inspect the meteorology equipment, instrumentation, and locations of installation. The compilation of pertinent meteorological data was also discussed.

Problems associated with a contemplated radioactive tracer study in the Mohawk River by the U.S. Geological Survey were reviewed. The U.S.G.S. requested KAPL's assistance in procuring isotopes and the required instrumentation.

Preparations were made to provide pertinent radiation protection and allied lectures for KAPL personnel. The initial program is restricted to "pilot" groups of selected laboratory personnel. Appropriate health physics lectures were given to Radiological Services personnel.

The following trip was made by a Radiological Services representative:

<u>Individual</u>	<u>Location</u>	<u>Purpose</u>
B. James	Attleboro, Massachusetts	Evaluate health physics problems for the Metal and Control Corporation

Operating and technical costs of the Radiological Services and Radiological Laboratory and Development Sub-Units were analyzed for fiscal year 1952. This review included a breakdown of gross expenditures to provide an indication of unit costs.

Capital equipment requirements were established for fiscal years 1954 and 1955.

A manual of counting-room procedures was completed. This manual is intended to provide a detailed presentation of the methods used and will serve both as an instruction manual for trainees and as a reference for the counting-room operators.

The Plant Services Unit and the Laboratory and Development Sub-Unit cooperated in establishing a new system for maintaining records of Plant Services personnel, which should provide a basis for improved coverage of bioassay monitoring.

ORGANIZATION AND PERSONNEL

At the end of March, 52 persons were employed in the Radiological Services and Laboratory and Development Sub-Units of the Health and Safety Unit. There were four additions, four terminations, and two transfers within the Laboratory.

An organizational chart of the Health and Safety Unit is shown on page 11.

11

EMPLOYEE RELATIONS SECTION

HEALTH AND SAFETY UNIT

L. L. German, Acting Head

MEDICAL AND
INDUSTRIAL HYGIENE
SUB-UNIT

P. W. Reynolds, M.D.
Medical Supervisor

SAFETY
SUB-UNIT

L. H. B. Peer
Safety Supervisor

RADIOLOGICAL
SERVICES
SUB-UNIT

L. J. Cherubin
Head

RADIOLOGICAL
LABORATORY AND
DEVELOPMENT
SUB-UNIT

R. Z. Bouton
Head

RADIOLOGICAL SERVICESGeneral Statistics

<u>Item</u>	<u>Department</u>		<u>Total No.</u>
	<u>No. Technical</u>	<u>No. Operating</u>	
Radiation work permits processed	1,006	1,037	2,043
Routine and special surveys	833	553	1,386
Hand exposure studies	804	879	1,683
Handscores recorded	3,279	7,889	11,168
In-Plant air monitoring samples	2,359	3,761	6,120
Calibrations	-----	-----	4,084
Pocket meters read	-----	-----	56,115
Film badges processed	-----	-----	13,348
Finger ring film processed	-----	-----	3,988
Environmental air monitoring measurements	-----	-----	1,802
Solids monitoring samples	-----	-----	356
Water monitoring samples	-----	-----	332

Personnel Exposures and Investigations

Total body overexposures	1	3	4
Total body exposures <u>> 0.3 r/week, < 0.6 r/week</u>	-	-	-
Head overexposures	4	2	6
Head exposures <u>> 0.3 r/week, < 0.6 r/week</u>	23	1	24
Hand exposures <u>> 1.5 rep/week</u>	5	2	7
Radiation hazard incidents	3	3	6
Investigations by supervision	33	8	41

Exposure investigations led to added training of persons in self radiation monitoring, a study of the effect of a solvent sealer on finger ring film units, and the discovery that film monitoring units were being stored improperly during periods of nonuse. Radiation hazard incident investigations resulted in a change in the plutonium sample analysis setup, clarification of the method of monitoring and labelling samples by amending procedures, correction of the build-up of pressure in rejected analytical samples, and improvement of shielding in hoods to reduce head exposures.

In-Plant Radistion Monitoring - W. H. Truran

Radistion Surveys

Chemistry and Chemical Engineering. Typical surface contamination problems were encountered. A leeking process line in one laboratory produced a dose-rate of 9 rep/hr at cell wall contact. Unusual patterns of fission-product contamination were detected in a laboratory during a general clean-up and in the Building G-1 basement because of the plugging of a drain line.

Radioactive Materials Laboratory. Significant contamination was confined to cell facilities.

Separations Pilot Plant and Liquid Waste Process Buildings. In the Pilot Plant, extension of plutonium surface contamination increased in magnitude despite some decontamination efforts. Contamination near sampling stations continues to impede the effective reduction of the high level radiation dose-rates. Extension of floor contamination beyond change-room limits required a review of change-room practices.

In the Liquid Waste Process Building, general contamination of the 332-ft level occurred as a result of a slurry drum rupture. Dose-rates ranged up to 10 rep/hr at 3 in. and 3.5 r/hr at 6 in. Decontamination has not been completed. The remaining contamination levels are low. A dose-rate of 5 r/hr at 2 in. was discovered at the West Evaporator Feed rotameter but was reduced to 10 mr/hr at 2 in. by a natural self-cleaning process.

Metallurgy. Minor personnel contamination problems arose. An irradiated uranium specimen indicating 285 rep/hr at contact was properly shielded.

Plant Services. Difficulty was experienced in unloading a cask from a freight car because the cask had slipped its mooring and had broken through the car floor.

Physics. The PPA and TTR were operated within normal power-level ranges. Dose-rates encountered by personnel did not exceed 900 mr/hr at reactors or 20 rep/hr from irradiated material.

Air Monitoring

The general pattern of air-borne contamination remained the same. Air-borne fission-product contamination in the Liquid Waste Processing Building was alleviated by correcting several potentially contributing conditions. Modification of component steaming operations in Building D-4 eliminated high uranium concentrations there. Respiratory protection was resorted to in those areas where ventilation is inadequate to maintain radioactive air-borne materials below required levels and operating practices cannot be changed.

The tabulations on pages 15 and 16 indicate air-borne concentrations in the general atmosphere and in the Stack Air Effluent, respectively.

Waste Disposal

There was no significant change in the normal variations in total activity discharged into the atmosphere or into the Mohawk River.

The tabulation on page 17 shows waste disposal into the atmosphere, Mohawk River, and accumulated slurry drums.

Environmental Radiation Monitoring - R. W. Trevithick

General Radiation Levels

General radiation levels at the Knolls Site were not affected by low-level atmospheric contamination produced by local operations or the atomic bomb detonations. Two air monitoring stations indicated above natural radiation backgrounds due to proximity to radioactive-waste storage areas. Detachable ionization chambers at near ground level averaged 0.4 mrep/24 hours to 1.0 mrep/24 hours.

Concentrations of Air-Borne Contaminants

Beryllium. Discharge by D-3 and D-4 stacks was estimated not to exceed 62 milligrams. Outdoor concentrations were below $0.01 \mu\text{g}/\text{M}^3$.

Alpha Activity. No statistically significant concentrations were established on the site.

Fission Products. Significant concentrations were attributed primarily to local operations. Biweekly average concentrations did not exceed $2.1 \times 10^{-10} \mu\text{c}/\text{cc}$ or a peak concentration of $3.5 \times 10^{-9} \mu\text{c}/\text{cc}$, which persisted for approximately one hour. Average biweekly concentrations ranged from $< 3 \times 10^{-13} \mu\text{c}/\text{cc}$ to $2.1 \times 10^{-10} \mu\text{c}/\text{cc}$.

Tritium. No tritium activity was detected at the warehouse air monitoring station, which is located in the prevailing wind direction from stacks discharging tritium.

15

Air Monitoring Surveys
General Atmosphere

Alpha and Fission-Product Concentration

Section or Unit	Total No.	No. > 4×10^{-12} $\mu\text{c alpha/cc}$	No. > 2×10^{-10} $\mu\text{c fp/cc}$	Maximum Activity	
				$\mu\text{c fp/cc}$	$\mu\text{c alpha/cc}$
Chemistry and Chemical Engineering	1845	1	2	2.3×10^{-10}	6.3×10^{-12}
Process Operations	2384	8	43	1.0×10^{-6}	1.6×10^{-11}
Radioactive Materials Laboratory	58	0	0	8.5×10^{-11}	$< 3 \times 10^{-13}$
Metallurgy	59	0	2	5.4×10^{-10}	$< 3 \times 10^{-13}$
Manufacturing	---	---	---	---	---
Plant Services	90	15	8	7.9×10^{-10}	1.6×10^{-10}
Physics	127	0	0	1.2×10^{-11}	2.3×10^{-12}

Uranium

Section or Unit	Total No.	U-238 $\mu\text{g/cc}$		Total No.	U-238 and/or U-235 $\mu\text{c/cc}$	
		No. > 5×10^{-5}	Maximum		No. > 3.4×10^{-11}	Maximum
Chemistry and Chemical Engineering	12	-	2.3×10^{-5}	2	--	3.2×10^{-13}
Physics	7	1	7.8×10^{-5}	-	--	---
Manufacturing	554	7	2.2×10^{-4}	85	11	1.6×10^{-9}
Metallurgy	100	-	9.8×10^{-6}	4	---	---

Beryllium

Section or Unit	Total No.	$\mu\text{g/M}^3$	
		No. > 2	Maximum
Chemistry and Chemical Engineering	10	0	< 0.01
Physics	6	0	0.24
Manufacturing	99	0	1.2
Plant Services	66	0	0.35
Metallurgy	47	0	< 0.1

I-131

Building	Total No.	$\mu\text{c/cc}$		
		No. < 10^{-11}	No. > 10^{-11} < 10^{-10}	Maximum
G-2 and H	2	1	1	2.4×10^{-11}

Tritium

Location	Total No. Indications	Range of Concentrations - $\mu\text{c/cc}$
Building E-1	18	1.0×10^{-5} to 3.3×10^{-3}

~~CONFIDENTIAL~~

Air Monitoring Surveys
Stack Air Effluent

Alpha and Fission-Product Concentrations

<u>Section or Unit</u>	<u>Total No.</u>	<u>No. $> 4 \times 10^{-12}$</u>	<u>No. $> 2 \times 10^{-10}$</u>	<u>Maximum $\mu\text{c/cc}$</u>	
		<u>$\mu\text{c alpha/cc}$</u>	<u>$\mu\text{c fp/cc}$</u>	<u>Fission Products</u>	<u>Alpha</u>
Chemistry and Chemical Engineering	48	0	0	$< 10^{-11}$	3.1×10^{-14}
Radioactive Materials Laboratory	22	0	0	$< 10^{-11}$	1.7×10^{-14}
Plant Services	60	0	0	7.8×10^{-11}	1.2×10^{-12}
Metallurgy	12	0	0	$< 10^{-11}$	$< 10^{-14}$
Process Operations	68	2	22	5.0×10^{-7}	9.4×10^{-12}

Urenium

<u>Unit</u>	<u>Total No.</u>	<u>U-238 $\mu\text{g/cc}$</u>		<u>Total No.</u>	<u>U-235 $\mu\text{c/cc}$</u>	
		<u>No. $< 10^{-6}$</u>	<u>No. $> 5 \times 10^{-5}$</u>		<u>No. $< 3 \times 10^{-13}$</u>	<u>No. $> 3.2 \times 10^{-11}$</u>
Manufacturing	87	87	0	44	44	0

Beryllium

<u>Unit</u>	<u>Total No.</u>	<u>$\mu\text{g/M}^3$</u>		<u>Maximum</u>
		<u>No. < 0.1</u>	<u>No. $> 0.1 < 2.0$</u>	
Manufacturing	143	143	0	0.02
Plant Services	64	64	0	< 0.01

I-131

<u>Building</u>	<u>Total No.</u>	<u>$\mu\text{c/cc}$</u>					<u>Maximum</u>
		<u>No. $< 10^{-11}$</u>	<u>No. $> 10^{-11}$</u>	<u>$< 10^{-10}$</u>	<u>No. $> 10^{-10}$</u>	<u>$< 10^{-9}$</u>	
G-2	15	5	9		1	0	2.3×10^{-10}

Tritium

<u>Location</u>	<u>No. Indications</u>	<u>Range of Concentrations, $\mu\text{c/cc}$</u>
Building E-1	90	1.0×10^{-5} to 3.2×10^{-3}

17

Waste Disposal

Into Atmosphere

<u>Source</u>	<u>Alpha Activity</u>		<u>Beta-Gamma Activity</u>		<u>I-131</u>	
	<u>Quarter</u>	<u>Year to date</u>	<u>Quarter</u>	<u>Year to Date</u>	<u>Quarter</u>	<u>Year to Date</u>
From Pilot Plant Stack	224 μ c	224 μ c	2.36 c	2.36 c	1890 μ c	1890 μ c

Into Mohawk River

<u>Source</u>	<u>Alpha Activity</u>		<u>Beta-Gamma Activity</u>		<u>I-131</u>	
	<u>Quarter</u>	<u>Year to date</u>	<u>Quarter</u>	<u>Year to Date</u>	<u>Quarter</u>	<u>Year to Date</u>
From Liquid Waste Processing Building H to Mohawk River	20.4 μ c	20.4 μ c	8658 μ c	8658 μ c	---	---

Accumulated Slurry Drums

<u>Total No.</u>	<u>Range - r/hr</u>	
	<u>Quarter</u>	<u>Year to Date</u>
29	1.5 - 4.4	1.5 - 4.4

Precipitation

Snow and rain samples during this period indicated significant concentrations of fission products. In January, concentrations of 2.7×10^{-7} μc fp/cc and 2.1×10^{-7} μc fp/cc were determined in precipitation at the Knolls and West Milton Sites, respectively. Later in the quarter, precipitation samples indicated up to 4×10^{-6} μc fp/cc and 2.7×10^{-6} μc fp/cc at the Knolls and West Milton Sites, respectively.

Vegetation

Vegetation contamination with nonvolatile fission products reached a maximum at 1.2×10^{-4} $\mu\text{c/g}$ at the Knolls Site and 1.1×10^{-4} $\mu\text{c/g}$ at the West Milton Site. Precipitation contamination from atomic bomb detonations undoubtedly influenced vegetation contamination at both sites.

Water Monitoring

Sanitary and storm sewer water effluent contained normal concentrations of alpha and beta-gamma activity. The maximum concentrations were 26 d/m/liter for alpha activity and 2.4×10^{-6} $\mu\text{c/cc}$ beta-gamma activity. Mohawk River and off-site public drinking water samples did not indicate any significant concentrations of radioactivity. One test well near the Waste Processing Building tank farm continued to indicate traces of fission-product activity, while drainage water of the tank farm area occasionally revealed beta-gamma concentrations up to 2.0×10^{-7} $\mu\text{c/cc}$. No significant radioactivity was established in the three remaining test wells, one of which is a deep well to the water table.

Calibrations

Routine Calibrations

	<u>No.</u>	<u>Total, 1953</u>
Fixed instruments		
Gamma	23	23
Portable instruments		
Alpha	74	74
Beta	213	213
Gamma	283	283
X-ray	---	---
Neutron	---	---
Subtotal	593	593
Personnel meters		
Beta	150	150
Gamma	3341	3341
Subtotal	<u>3491</u>	<u>3491</u>
Total	4084	4084

Personnel MonitoringPocket Meters

	<u>No.</u>	<u>Total, 1953</u>
Total read	56,115	56,115
Single readings		
60 to 260 mr	22	22
Over 260 mr	48	48
Paired readings		
30 to 60 mr	570	570
65 to 260 mr	129	129
Over 260 mr	5*	5
Paired readings lost	1	1

*One of these was confirmed by film badge

Badges (A and V)

Total processed	9,763	9,763
Readings		
50 to 300 mrep	583	583
300 to 600 mrep	6	6
Over 600 mrep	4	4
Lost readings	0	0

Self-Service Badges

Total processed	2,130	2,130
Readings		
50 to 300 mrep	1	1
300 to 600 mrep	0	0
Over 600 mrep	0	0
Lost readings		
Wrong No. listed	101	101
No number listed	3	3
Name and/or No. illegible	7	7
Total	111	111

A total of 111 lost readings resulted from self-service film badge usage. No loss of readings occurred from regular badge usage.

Personnel Monitoring (Continued)

	<u>No.</u>	<u>Total, 1953</u>
<u>Finger Rings</u>		
Total processed	3,337	3,337
Readings		
50 to 500 mrep	2,226	2,226
500 to 1500 mrep	171	171
Over 1500 mrep	11	11
Lost readings		
Spoiled	42	42
Broken	9	9
Lost	20	20
Light leaks	8	8
Total	79	79
<u>Head Rings</u>		
Total processed	313	313
Readings		
50 to 300 mrep	227	227
300 to 600 mrep	34	34
Over 600 mrep	5	5
Lost readings		
Spoiled	0	0
Broken	2	2
Lost	0	0
Light leaks	3	3
Total	5	5

RADIOLOGICAL LABORATORY - R. Z. BoutonGeneral Statistics

<u>Samples Processed</u>	<u>Number of Samples Processed</u>			
	<u>January</u>	<u>February</u>	<u>March</u>	<u>Total, 1953</u>
Beryllium	208	276	302	786
Air	1980	1986	2256	6222
Smears	470	604	1483	2557
Water	117	87	134	338
Vegetation	36	42	74	152
Soil	3	3	8	14
Precipitation	57	42	20	119
SPP Scrubber	8	7	16	31
Ash	2	8	10	20
Evaporator condensate	2	3	2	7
HTO air composites	32	12	21	65
HTO urine specimens	21	15	37	73
Natural uranium urine specimens	---	20	31	51
Enriched uranium urine specimens	---	27	32	59
Plutonium urine specimens	58	43	103	204
Fission-product urine specimens	45	37	67	149
Other	59	11	---	70
	Total			10,917

Analytical

A total of 1604 radiological survey and regional survey samples was submitted to the Health Physics Analytical Laboratory for analysis. In addition to these samples, direct radioactivity measurements were performed on 8779 air samples and smears.

Evaluation of analytical data indicated satisfactory control of the laboratory operations. The detection efficiency of the analytical method for determination of total rare earths and yttrium averaged 75%, and the efficiency of the analysis for cerium averaged 60%. The recoveries of plutonium and uranium from regional water samples averaged 89 and 84%, respectively, with standard deviations of 6%. The spectrographic results of two beryllium control blanks, out of 94 blanks processed concurrently with the beryllium samples, revealed the probability of slight cross-contamination of samples.

The routine analyses performed on water, precipitation, soil, and ash samples included the solvent extraction of plutonium and uranium and a direct count of the total beta activity. Vegetation was also counted directly for total beta and analyzed for radioiodine and alpha emitters. The Separations Pilot Plant stack monitor-scrubber solutions and particulate material filtered from the stack effluent were analyzed for specific fission products in order to determine the isotopic composition of the effluent. The relative proportions of the radioactive components in the evaporator condensate discharged to the Mohawk River were also established by means of specific analyses.

Analysis of the Building H evaporator condensate revealed the following relative proportions of fission products:

<u>Isotope</u>	<u>Total Beta Activity, %</u>
Sr-89	10 ± 4
Rare Earths and Y-91	59 ± 10
I-131	4 ± 4
Ru-106 (Rh-106)	7 ± 4
Zr-95 and Nb-95	17 ± 13

These data indicate that the proportions of rare earths plus yttrium, zirconium plus niobium, and ruthenium varied from the proportions previously established; this change, however, was caused primarily by higher levels of zirconium and niobium discharged over a period of only a few days. The amounts of strontium and iodine were approximately the same as those previously reported.

In addition to the routine survey and regional sample analyses, 48 samples of laundry effluent were analyzed for plutonium and uranium. This work was performed as a service to the Chemistry and Chemical Engineering Section.

Methods of radiocesium analysis were reviewed for the purpose of establishing a procedure for routine use.

Specifications were obtained from Oak Ridge National Laboratory for a Multiple Burner Fusion Device to be used in the analytical determination of uranium.

The health physics counting room methods were reviewed, and changes were made in technique to provide improved efficiency and accuracy.

Bioassay

No significant excretions of plutonium, mixed fission products, enriched uranium, or natural uranium were detected through analysis of urine specimens submitted by KAPL personnel. Several positive tritium excretions were established, one of which approached the $20 \mu\text{c/liter}$ activity level, which, based on a weekly sampling frequency, represents the maximum permissible body burden of tritium.

Plutonium urinalyses were performed on 204 specimens during the reporting period. Seventeen of the specimens analyzed were control blanks, and 18 were control spikes. The remaining specimens were 24-hr urine collections submitted by KAPL personnel. The alpha activities of the latter specimens averaged $0.04 \pm 0.08 \text{ d/m}$, with a maximum for any one sample of $0.29 \pm 0.17 \text{ d/m}$. A re-sample from the individual submitting this highest activity specimen was $0.00 \pm 0.07 \text{ d/m}$. The average and maximum control blank activities were $0.05 \pm 0.10 \text{ d/m}$ and $0.15 \pm 0.13 \text{ d/m}$, respectively. The plutonium detection efficiency for the analytical method, as determined by analysis of control spikes, averaged 84% with a standard deviation of 9%.

A total of 149 urine specimens were analyzed for mixed fission products; 14 of these specimens were control blanks. The average beta activity of the 24-hr urine collections was 5.7 ± 8.7 d/m. The maximum activity detected was 28.9 ± 9.0 d/m. The average and maximum control blank activities were 5.3 ± 8.5 d/m and 15.1 ± 11.8 d/m, respectively.

Enriched-uranium urinalyses were performed on 59 specimens, and 24-hr urine collections were also obtained for this analysis. The average alpha activity detected was 0.1 ± 0.2 d/m. The maximum activity was 1.1 ± 0.6 d/m.

Fifty-one urine specimens, each representing a three-hour collection, were analyzed for natural uranium. The analytical results revealed an average excretion of $< 1 \mu\text{g}/24 \text{ hr}$ and a maximum excretion of $3 \mu\text{g}/24 \text{ hr}$.

Seventy-three urine specimens were analyzed for tritium. Nine initial excretions were detected which exceeded $1 \mu\text{c}/\text{liter}$ of urine; the maximum activity was $17 \mu\text{c}/\text{liter}$. The analysis of resamples indicated that the excretion levels were decreasing normally.

DEVELOPMENT

The health physics development problems under investigation during the current reporting period are summarized.

Stack Effluent Studies

Fission-Product Identification - J. J. Fitzgerald, M. R. Kennedy, R. Z. Bouton

The relative proportions of the fission products discharged from the Separations Pilot Plant stack were determined for the dissolving and head-end operations of nonrepetitive runs No. 12-16 and 17. The results were as follows:

Relative Proportions of Fission Products in Particulate Form

<u>Fission Product</u>	<u>Dissolving Operation, % Activity</u>	<u>Head-End Operation, % Activity</u>
Rare Earths	60	5
Zr-95 and Nb-95	18	8
Ru-106	10	86
Sr-89	10	< 1
I-131	< 1	< 1

These data are not significantly different from the findings for the fifth and seventh repetitive runs, reported in KAPL-814.*

*KAPL-814, "Semiannual Progress Report of Radiological Development Activities in the Health and Safety Unit, January to June 1952."

Calibration of Inert Gas Monitor - C. G. Detwiler

Further tests were conducted to determine the counting efficiency of the inert gas monitor located in the Separations Pilot Plant stack effluent sampling system. The activities of the krypton-85 samples used in the calibration are being determined by the Physics Section. If the results of these tests are satisfactory, the calibration of the monitor will be complete.

Aerosol Studies

Efficiency of Special Products Shop Air Cleaning System - C. G. Detwiler

The study was continued of the particle collection efficiency of the Special Products Shop electrostatic precipitator and glass wool air filtering unit.

A comparison of the size distributions of the general particulate material and the beryllium dusts carried by the high velocity duct leading to the plenum chamber, with the same materials in the plenum chamber, showed a lower mean particle size in the latter position. This difference is to be expected since the air from the high velocity duct is diluted in the plenum chamber with the air exhausted from the general shop areas. The geometric mean particle sizes of the general particulate materials in the high velocity duct and in the plenum chamber were 0.4 and 0.2 μ , respectively, with geometric standard deviations of 1.8 and 2.2. The geometric mean particle sizes of the beryllium aerosols, in the high velocity duct and in the plenum chamber, were 1.2 and 0.3 μ , respectively, with geometric standard deviations of 2.5 and 3.0.

The efficiency of the air cleaning unit as a function of particle size is being determined by microscopic size counts of particulate samples obtained both upstream and downstream from the unit. The upstream sampling position is in the plenum chamber. Four pairs of samples have been obtained with the air cleaning unit in varying states of cleanliness. These preliminary collection efficiencies for 0.2 μ particles were 40, 0, 50, and 33% under the following conditions: electrostatic precipitator and glass wool filter both dirty; precipitator turned off and filter dirty; and the last two efficiencies with the precipitator dirty and filter clean. The results reveal the inefficiency of the glass wool filter for small particles and indicate that when dirty, the precipitator is approximately 40% efficient for 0.2 μ particles.

Design of Aerosol Sampling Unit - C. G. Detwiler

A new sampling unit was designed for the collection of toxic and radioactive air-borne particulate materials. Special consideration was given to producing a sampler which could be used conveniently and rapidly and which would not allow air leakage under operating conditions. The sampling unit takes a 13/16-inch diameter filter paper and is intended for use in low-volume sampling operations, in the order of <1 to 14 liters/minute (6.6 to 92.4 cm/sec face velocity). The unit is particularly suitable for use with the molecular type filters and Whatman No. 40 filter paper, although other filter materials can be used.

The sampling unit consists of two concentric cylinders machined from dural. The inner cylinder is cut in half at right angles to the cylinder axis, and the filter material is held between the halves. The downstream half of the inner cylinder houses a No. 40 grit carbon backing disk to support the filter paper. An o-ring gasket is mounted on the face of the upstream half of the cylinder and contacts the filter paper, thus preventing leakage around the filter. The use of the o-ring in place of a standard gasket reduces the gasket bearing surface and produces a greater force per unit area of contacting surface, which results in a more leak resistant filter holder. Air leakage past the contacting surfaces of the inner and outer concentric cylinders is prevented by a second o-ring used in the conventional manner.

No air leakage was observed when the entire unit was submerged in water, with a plug in the downstream end and air pressure of 12 lb/sq inch applied to the upstream end.

The unit is convenient to use since the only operation necessary to open it is the removal of a sliding pin lock. When the pin lock is removed, spring loading on the inner cylinder slowly pushes the upstream half of the inner cylinder out of the housing, exposing the filter for easy removal.

Filter Efficiency Studies

Investigation of Several Aerosol Filters - C. G. Detwiler

An investigation was begun of the particle collection efficiencies of several filter papers used by the radiological services in aerosol monitoring and air cleaning. This study is intended to extend and supplement the efficiency data previously obtained for the Whatman No. 40 and Hollingsworth Vose H-70 filters.* To provide assurance of consistency in the experimental results, the present investigation will include a re-evaluation of these two papers as well as tests with the CC-6 (or CWS-6), AAA Fiberglass, Whatman No. 41, and AEC No. 1 filter (A.D. Little paper used in the Absolute Filter).

To date, efforts have been confined primarily to modifying the laboratory aerosol generator and determining the probable inherent errors in technique. As a result of this evaluation of methods, several changes have been made in technique. For example, it was found that the air flow rate calibrations for the orifice flow meters, which were used to control the air flow through the aerosol generator and the test filters, had deviated from the previously established values. To ensure proper flow rate measurement, the orifice meters were replaced with Fisher-Porter rotameters. Calibration of the rotameters has indicated a standard deviation, at the flow rates of interest, of less than 3%. The aerosol distributions and concentrations produced by the generator have also been examined to determine the variations in these physical characteristics at different sampling positions. The variations encountered have been no greater than could conceivably be caused by additive rotameter errors.

*KAPL-575, "Semiannual Progress Report of Development and Research Activities in the Health Physics Division," July 1, 1951.

The filter efficiency data obtained thus far on the Whatman No. 40 paper is tabulated below. Previously determined efficiencies for this same type of filter paper are also listed.

Whatman No. 40 Particle Collection Efficiencies

<u>Particle Size, μ</u>	<u>Face Velocity, cm/sec</u>	<u>Previous Efficiencies, %</u>	<u>Current Efficiencies, %</u>
0.2	10	72.	59.
0.4	10	75.	72.
0.6	10	86.	91.
1.2	10	96.	96.
1.8	10	99.	97.
0.2	20	95.	95.
0.4	20	95.	97.
0.6	20	97.	98.
1.2	20	99.	98.
1.8	20	> 99.	99.

The data reveal a significant difference between previous and current efficiency results only for the 0.2 μ particles collected at a face velocity of 10 cm/sec.

Investigation of H-70 Filter Paper - C. G. Detwiler

Tests were performed to determine the effects of the apparent change in the structure of the Hollingsworth and Vose H-70 filter paper, obtained from a recent shipment, on the air flow rates through the paper.

A comparison of the flow rates through the paper with the flow rates through the same type of paper obtained in 1951 and 1952 is presented in the following tabulations. The results are shown as a function of pressure drop across the papers. The pressure differentials were selected to provide the flow range normally used in aerosol sampling.

Flow Rate as a Function of Pressure Drop

<u>Pressure Drop, cm H₂O</u>	<u>Flow Rate in cfm through H-70 Paper</u>		
	<u>1951</u>	<u>1952</u>	<u>1953</u>
4.3	1.0	0.9	1.3
13.4	3.0	3.3	4.5
22.5	5.0	5.7	7.5

The data indicate that the structure and/or composition of the 1953 paper differ from both the 1951 and 1952 papers. The flow rate through the 1953 paper is higher by 35 to 50% than the flow through the 1951 paper, at the specified pressure differentials. These flow rates are significantly higher than the values for the older paper since the maximum standard deviation of the results obtained at any one pressure drop, on different lots within the 1953 shipment, was $\pm 7\%$.

Instrumentation and Calibration

Neutron Spectrum Determination - J. J. Fitzgerald

Neutron fluxes were determined from foil activation data at three different positions external to the PPA. The positions that were checked included two positions in the control room adjacent to the PPA and one point just outside the door to the assembly room. Analysis of the data has indicated the thermal neutron flux to be as follows:

Thermal Neutron Flux

<u>Position</u>	<u>Power Level, Watts</u>	<u>Cadmium Ratio for Indium</u>	<u>Thermal Flux, n/cm²/sec</u>
PPA door	0.7	1.3	< 1
PPA door	4.	1.6	~ 4.
Control Room wall (8 ft west of stationary assembly)	0.7	No detectable flux	
Control Room wall (Directly adjacent to stationary assembly)	4.	1.9	168.

The only significant thermal flux detected in the control room was at a point along the control room wall adjacent to the assembly during an operation at a power level of 4 watts. This flux, of 168 n/cm²/sec, is approximately one-fourth of the flux accepted at KAPL as maximum permissible.

Neutron Monitoring - J. J. Fitzgerald

The investigation of the neutron detection efficiency of a moderated BF₃ tube was continued, following the procurement of a more reliable antimony-beryllium source of intermediate neutrons. The BF₃ tube detection efficiencies determined for the neutrons emanating from antimony-beryllium, polonium-beryllium, and radium-beryllium sources were as follows:

Neutron Detection Efficiency

Source	Average Neutron Energy, Mev	Efficiency, %		
		1.3 cm polystyrene moderator	2.5 cm polystyrene moderator	3.8 cm polystyrene moderator
Ra-Be	5.0	0.006	0.04	0.10
Po-Be	2.5	0.10	0.40	1.3
Sb-Be	0.03	0.16	0.60	1.3

The data indicate higher ratios of intermediate to fast neutron detection, with the use of decreasing thicknesses of moderator, but at the expense of absolute efficiency for neutrons in both energy ranges.

Neutron Source Calibration - J. J. Fitzgerald

The antimony-beryllium intermediate neutron source obtained from Oak Ridge was calibrated. The source strength was found to be 3.6×10^5 n/sec.

Substitute for Sigma Pile - J. J. Fitzgerald

A unit has been designed which may serve as an adequate substitute for a Sigma Pile in the calibration of neutron detectors. The unit uses water rather than graphite as the moderator and should permit calibrations in the order of 1/10 to 10 times the maximum permissible flux of thermal neutrons.

A preliminary model of the calibration unit is now being constructed.

Calibration of Critical Velocity Orifices - C. G. Detwiler

The critical velocity orifices used in health physics air monitoring were calibrated to establish the minimum vacuum required to obtain the rated air flow. The minimum vacuum was 15 inches of mercury for all orifices tested throughout the 1.2 to 35.2 liters/min air-flow range. This calibration value checks with the theoretical minimum vacuum required to provide sonic velocity through the orifices.

General Investigations

Determination of Maximum Permissible Concentration of Thorium - J. J. Fitzgerald

Further investigation of the factors affecting the maximum permissible concentration of thorium in air has indicated that the assumption of no lung absorption of the daughter products is probably not entirely valid. The daughter products would probably not remain in the lungs since mesothorium-1,

which is the first daughter of thorium-232, is a radium isotope and should behave as an alkaline earth. Recalculation of the maximum permissible concentration of insoluble compounds of thorium in air, assuming that only the parent isotope remains in the lungs, has given a value of 7×10^{-13} $\mu\text{c/cc}$. As previously reported, the maximum permissible concentration is 1×10^{-13} $\mu\text{c/cc}$ if one assumes no lung absorption. The mean of these two values, 4×10^{-13} $\mu\text{c/cc}$, checks with the maximum permissible concentration suggested several years ago at a medical conference at MIT.*

Evaluation of Hazards Resulting from a Nuclear Incident - J. J. Fitzgerald

Studies were initiated of the essential calculations and derivations associated with the prediction of hazards resulting from unusual reactor incidents. The work includes the study of Sutton's diffusion equations, the evaluation of methods for calculating dosage at ground level due to a passing radioactive cloud, methods for estimating rain-out and fall-out, and other related calculations.

Laboratory Hood Efficiency Study - C. G. Detwiler

A topical report of the results of the study of laboratory fume hood efficiencies was completed. The report is KAPL-864, "Performance Study of Laboratory Fume Hoods."

U. S. GEOLOGICAL SURVEY - E. S. Simpson

Hydrologic Investigations

Operation of stream gauging station on Glowegee Creek was continued.

Operation of recording gauge for gauge height record on Mohawk River at KAPL was continued.

Investigation of the discharge of suspended sediment and dissolved solids of Kayaderossaras and Glowegee Creeks in the West Milton area was started on March 1, 1953. A sediment sampling station was installed on Kayaderossaras Creek at the highway bridge about 0.4 mile below the confluence with Glowegee Creek. Separate measurements of the discharge of suspended sediment of Glowegee Creek will be made to establish the relationship between the sediment discharge of the two creeks.

Sampling Program

Water and sediment samples for radioanalyses at KAPL were resumed in January as per schedule.

*TID-217, "Report of Medical Discussion During a Visit of United Kingdom and Canadian Personnel to MIT on December 7, 1948," by E. S. Wolf, March 3, 1949.

Daily sampling of the Mohawk River water at Vischer Ferry dam for suspended sediment and dissolved minerals was continued. About 300 samples were analyzed in the laboratory for concentration of suspended sediment.

Tracer Study

Plans are being developed for the resumption and probable conclusion of tracer studies of the Mohawk River during the coming field season. Analysis of previous studies utilizing the NaCl brine made it apparent that evaluation of dilution and dispersion characteristics of KAPL sewer effluent in the Mohawk River might be enhanced if a radioactive isotope were used as a tracer. Radioisotopes and instrumentation requirements for the radioactive tracer study of the Mohawk River were specified.

Adsorption Studies

Laboratory investigation of the adsorptive characteristics of Mohawk River sediment with respect to radioisotopes is being carried on by KAPL personnel using samples collected and prepared by the U.S.G.S. Samples of bottom sediment and of suspended sediment were collected, separated into size fractions, and delivered to KAPL. Part of each sample was sent to U.S.G.S. laboratories in Washington for mineralogical examination. Preliminary results on adsorption are available but have not yet been released.

Personnel Services and Preparation of Reports

Office computations were completed on geophysical exploration of unconsolidated overburden in the West Milton area. The final report is being prepared.

Miscellaneous consultative services and information relative to geologic and hydrologic conditions affecting KAPL operations were provided.